Vol. 13 JANUARY, 1948 No. 1

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F-M ANTENNAS*

A Discussion[1] of the Design, Operation and Installation of Antennas Which Can Be Used for F-M. Factors Considered Include Height, Polarization, Reflection, Transmission Lines and Impedance Matching.

The advent of highly-efficient loop type antennas and high-gain input circuits in a.m. receivers outmoded outdoor antenna installations, in many instances. Today with the increasing popularity of f-m sets, we find that the outdoor antenna is once more an essential factor. For, in many areas, an outdoor antenna is required to provide sufficient pickup to properly operate the f-m limiter and provide noise- and distortion-free signals.

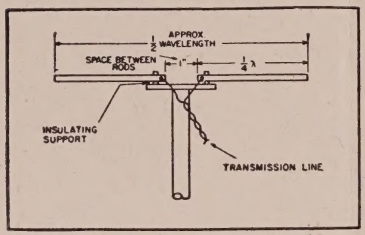


Fig. 1. A half-wave dipole antenna used for f-m.

Since the f-m carrier is at a much higher frequency than that for a-m transmission, it is necessary to use an antenna that will be efficient at these higher frequencies. Experience has shown that an outside antenna of the dipole type, correctly installed, will give the best results.

The Half-Wave Antenna

The simplest antenna for f-m reception is the half-wave dipole and consists of two quarter-wave rods spaced about 1" apart at the center. This antenna provides a radiation resistance or about 72 ohms at resonance. A dipole resonates when its length is approximately equal to one-half wavelength of the frequency that it is to be used on.

The over-all length of a half-wave dipole for any desired frequency can be computed from the equation: L (in feet) $= \frac{492 \times .94}{\text{Frequency (mc)}}$. Each rod of the dipole will then be one-half the over-all length. The factor .94 compensates for the end effect of a half-wave antenna at high frequencies and consequently the actual length of a half-wave antenna will not be exactly equal to one-half wavelength of the frequency it is to be operated on, but will be about 5% less.

In actual practice the length of the antenna depends upon a number of factors. If the antenna is to pick up signals from only one station, then the over-all length should be calculated from the middle of the frequency band for that particular station. However, in most cases it is desired to be able to pick up signals from a number of different stations in the band and therefore some compromise must be made in the exact length of the antenna. The usual procedure is to cut the antenna so that it will be ½ wavelength long at the center of the range it is desired to cover. For a range of frequencies of from, let us

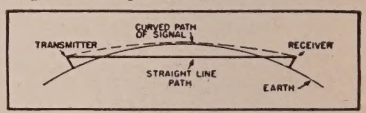


Fig. 2. Refraction path of an f-m signal.

say, 42 to 46 mc, the antenna should be cut so that it will be ½ wavelength long at a frequency of 44 mc. Substituting this value in the foregoing equation, we find that the over-all length of the antenna would be:

$$L \text{ (in feet)} = \frac{492 \times .94}{44} = 10' \ 6",$$

** By courtesy of "Service" magazine.*
[1]Data courtesy G.E.

and thus the length of each half of the dipole would be 5′ 3″.

Range of F-M Signals

For all practical purposes the frequencies assigned to f-m are too high to be refracted back to earth by the ionosphere, as is the case for frequencies somewhat lower. The critical frequency above which refraction in the ionosphere fails to return signals back to earth depends upon the electron density of the ionized region which has daily, seasonal, and yearly variations, dependent upon the sun's radiation. For this reason f-m must depend upon waves travelling directly from transmitter to receiver through the space above the ground. However, due to the curvature of the earth the range of the signals is limited to moderate distances.

Signals received over a greater distance than the straightline path are unreliable because of such factors as refraction. Refraction of ultra-high frequencies by the earth's atmosphere comes about because the variation of

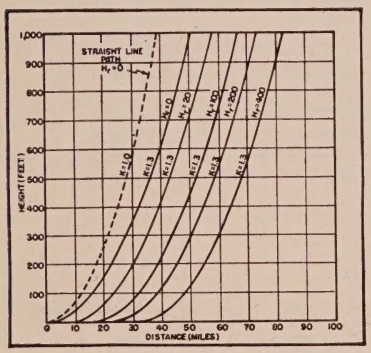


Fig. 3.

Curves showing effects of antenna heights and atmospheric refractions upon the direct line-of-sight transmission. Distance = $1.23K\ (\sqrt{H_t} + \sqrt{H_r})$; where H_t = transmitter antenna height (feet), H_r = receiving antenna height (feet), and K = factor (varies between 1.25 and 1.35).

atmospheric temperature, pressure, and moisture content with height, cause the refractive index of the atmosphere to decrease with elevation and tends to bend the waves back toward the earth. The amount of curvature that results varies with at atmospheric conditions but, on the average, it is equivalent to assuming that the earth's diameter is increased by 25 to 35 per cent. However, due to the continually varying conditions upon which this refraction depends, it is obvious that a signal travelling along this path will not be reliable and, consequently, we must depend upon the straight-line path or the line-of-sight path for dependable f-m reception.

The range of a station, considering only the straight-line path depends upon the heights, H_t and H_r, of the transmitting and receiving antennas respectively.

According to the formula: Maximum distance for straight-line path = $1.23\ (\sqrt{H_t} + \sqrt{H_r})$, where the antenna heights are in feet and the distance is in miles.

If atmospheric refraction is considered, the distance is increased by a factor of 1.25 to 1.35, depending upon the atmosphere's refractive index, K. In Fig. 3 there are several curves showing the effect of antenna heights and atmospheric refractions upon the direct line-of-sight transmission. With the exception of the path, all curves are calculated on the basis of the effective range being increased by a factor 1.3 because of refraction in the earth's atmosphere. In Table 1 appears a chart giving the range for several transmitting antennas in excess of 1,000′. It is of interest to note that when one antenna is high (usually the transmitting antenna) and the other relatively low, a given number of feet increase in either antenna is much more effective in increasing the range if it is applied to the lower antenna. This fact may not at first be apparent until we reconsider the fact that the line-of-sight range is directly proportional to the square root of the height of either antenna. For example, if one antenna is 10′ high and the other

Table 1—Transmitter heights above 1000'.

Height	Straight Line Path	With Atmospheric Refraction, K=1.3	Hr 20'	Hr 40'	Hr 100'	Hr 200'	Hr 400'
1,250	44	57	64	67	73	79	89
1,500	48	62	69	72	78	85	94
2,000	55	72	79	82	88	94	104
3,000	68	88	95	98	104	111	120
4,000	78	101	108	111	117	124	133
6,000	95	123	130	133	139	146	155
10,000	123	160	167	170	176	183	192

1,000' high, the straight-line path in miles will equal:

$$D=1.23\ (\sqrt{10}+\sqrt{1000})$$
$$=1.23\ (3.16+31.6)=42.75 \text{ miles}$$

Now suppose we increase the height of the lower antenna by 90', the straight-line path will now be:

$$D=1.23\ (\sqrt{100}+\sqrt{1000})$$
$$=1.23\ (10+31.6)=51.8 \text{ miles}$$

Now suppose that instead of increasing the lower antenna by 90', we had increased the higher antenna by 90', the straight-line path would have then been:

$$D=1.23\ (\sqrt{10}+\sqrt{1090})$$
$$=1.23\ (3.16+33)=44.5 \text{ miles}$$

From the foregoing example, it is obvious that since receiving antennas are relatively low and transmitting antennas relatively high that increasing the height of the receiving antenna is much more effective than increasing the height of the transmitting antenna an equal amount. Therefore, the importance of placing the receiving antenna as high as possible when the receiver is located a considerable distance from the transmitter.

Polarization of Antenna

Since a radio wave consists of magnetic and electrostatic fields at right angles to each other, the polarization of a radio wave simply means the relationship of the electrostatic field with respect to the earth as the radio wave travels into space. If the electrostatic field is vertical with respect to the earth, the radio wave is said to be vertically polarized. If the electrostatic field is horizontal with respect to the earth, the radio wave is said to be horizontally polarized. If the arms of a dipole transmitting antenna are vertical with respect to earth, then the antenna is said to be polarized vertically and for maximum induced voltage the receiving antenna should also be vertically polarized, i.e., the arms of the receiving dipole should also be vertical with respect to earth.

If the arms of the transmitter dipole are horizontal with respect to the earth, then it will send out a horizontally polarized wave and therefore for maximum signal pickup the receiving antenna should also be horizontally polarized.

It has been found that a horizontally polarized receiving antenna is less susceptible to ignition noise and other electrical interference and, consequently, most f-m transmitting antennas send out a horizontally polarized wave.

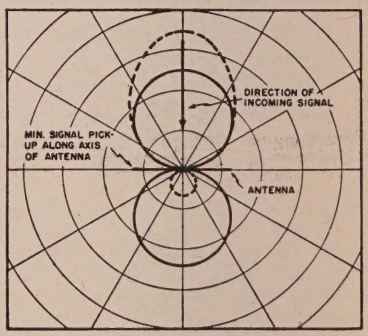


Fig. 4. Horizontal directivity pattern of a dipo.

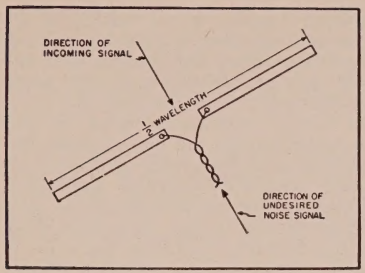


Fig. 5. Signal response of a half-wave dipole.

Response Characteristics of the Dipole Antenna

The solid curve of Fig. 4 illustrates the horizontal directivity of a horizontal dipole antenna. As shown, the signal pickup is greatest when the signal arrives in a direction that is at right angles to the broad side of the antenna. In other words, for maximum signal pickup, the broad side of the antenna should be pointed in the direction in which the signals are arriving from, i.e., toward the transmitting antenna. An inspection of the plot shows that in the direction along the axis of the antenna the signal pickup is practically zero. Use can be made of this fact in locations having a high-noise level by rotating the antenna so that its axis points in the direction from which the noise signal is arriving. Such an orientation may decrease the signal pickup somewhat since the broadside of the antenna may not be pointing exactly in the direction of the arriving f-m signal, but will be very beneficial because of the very great reduction in noise signal pickup.

As shown by the plot, the horizontal dipole responds equally well to signals arriving in either direction that are at right angles to the broad side of the antenna, and under certain conditions this is undesirable.

Noise Source

For instance if there is a noise source near the antenna such that the noise signal from it arrives in a direction that is just the opposite from that of the arriving f-m signal, as shown in Fig. 5, it will greatly reduce the signal-to-noise ratio which may result in poor reception. This undesired condition can be greatly reduced by making use of a reflector. A reflector is simply another rod which is placed parallel to and in back of the receiving dipole. The reflector element is usually about 5% longer than the receiving dipole and is placed about ¼ wavelength in back of the receiving dipole with a resulting gain in signal pickup of about 3 db in the direction in which the broadside of the receiving dipole is pointed; a half-wave dipole with a reflector is shown in Fig. 6. The directional characteristics are illustrated by the dashed curve in Fig. 4 and, as shown, results in strengthening the desired signal and also in greatly reducing any interfering signal that comes from a direction which is directly in back of the receiving dipole.

When a reflector is added to the regular dipole, it increases the antenna directivity considerably, so that the orientation of the antenna array with respect to the direction of the incoming signal is a rather critical adjustment for optimum results. When installing antennas of this type it is usually advisable to check the results of rotating the antenna by listening to the receiver. This normally re-

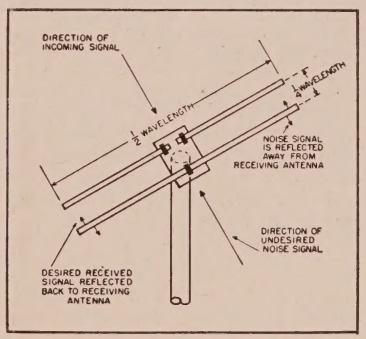


Fig. 6. A dipole mounted with a reflector.

quires two men to make the installation, one on the roof at the antenna and the other at the receiver, with an intercom system to relay two-way messages.

Transmission Lines

A transmission line is used to transfer power with a minimum of loss from its source to the device in which the power is to be usefully expended. At r-f where every wire carrying r-f current tends to radiate energy in the form of electromagnetic waves, special design is necessary to minimize radiation and thus permit as much as possible of the input power to be delivered to the receiving end of the line. There are various types of transmission lines in use, namely, the open-wire line which consists of two parallel wires maintained at a fixed spacing of a few inches by insulating spacers; the twisted-pair line which consists of two rubber-insulated wires twisted together to form a flexible line; the coaxial or concentric line which uses a wire conductor centered inside of a metal tube which is used as the outer conductor; the flexible coaxial line which uses solid insulation between the inner and outer conductors, instead of spacers or beads, with the outer conductor being made of copper braid rather than solid tubing so that the line will be flexible; the shielded pair balanced to ground which consists of two parallel wires maintained at a fixed spacing by solid insulation around which is an outer shield of copper braid.

Twisted and Parallel Lines

The open-wire line has a fairly low attenuation loss per wavelength, but due to its rather high surge impedance it is more difficult to balance out extraneous signal pickup. The most usual method of transferring the signal from the antenna to the receiver is by means of a low-impedance twisted or parallel pair transmission line, which has a surge impedance of about 100 to 300 ohms. An ordinary twisted pair line is not satisfactory for this purpose since it probably will not have the correct surge impedance and will also probably have a high attenuation loss. A special type of twisted or parallel pair line is made for this purpose, having the correct surge impedance and the proper kind of insulating material to keep the attenuation losses as low as possible, even after being exposed to the elements. However, even the best line has a fairly high attenuation loss, about 3 db per 50′ of length at 100 mc. A twisted or parallel pair transmission line is usually satisfactory for distances up to about 100′, but for distances beyond this it is advisable to use one of the low-loss transmission lines, such as the coaxial line or the shielded pair balanced to ground.

Impedance Matching

In the foregoing paragraph, mention was made of the surge impedance of a transmission line. The characteristic or surge impedance of a line is not determined by the ohmic resistance of the conductors, but by the construction of the line and is equal to the square root of the ratio of inductance to capacity per unit length of line; thus $Z_o = \sqrt{L/C}$. Therefore, every transmission line has a characteristic or surge impedance which acts as a pure resistance the value of which depends on the construction of the line.

If a transmission line is terminated in its characteristic or surge impedance, it is equivalent to an infinitely long line and there will be no standing waves or reflections along the line and the line is said to be non-resonant. The input end of a transmission line that is terminated in a resistance equal to its surge impedance will appear as a pure resistance having a value equal to the characteristic or surge impedance of the line.

However, if the transmission line is not terminated in a load that equals the surge impedance of the line, then there will be standing waves produced along the line which may re-

sult in a serious loss of signal between the antenna and the receiver, depending upon the amount of mismatch between the load impedance and the surge impedance of the transmission line.

For maximum transfer of power from the source to the load, it is necessary that the load impedance be equal to the source impedance. When the average resistance at the center of a half-wave dipole varies from about 72 to 100 ohms, the antenna input circuit of the receiver is designed for an imepdance of about 100 ohms, so that there will be a maximum transfer of energy from antenna to receiver.

The transmission line is usually balanced to ground by means of a center tap on the primary of the antenna transformer so that any noise signal picked up by the line will cancel out.

From the foregoing it is evident that for the maximum transfer of signal from the antenna to the receiver it is necessary that the surge impedance of the transmission line match the input impedance of the receiver at least fairly closely, and also that the input impedance of the transmission line match the impedance at the center of the dipole.

Installation of F-M Antennas

The first step in installing an f-m antenna is to make a survey of the location and check on the line-of-sight of direction between the f-m station and the receiver and also determine the location of possible noise interference sources. It is also necessary to determine what the length of the transmission line is to be. If over 100′ it is advisable to use a low-loss line, such as a coaxial line, unless the antenna is in a location where the signal strength is quite high.

As a general rule, the antenna should be as high as possible and as far from any noise source as feasible, always bearing in mind that the longer the transmission line the greater will be the line loss. In residential sections, a height of from 30′ to 40′ above the ground or 10′ to 20′ above the roof is, in most cases, satisfactory.

Automobile Ignition Troubles

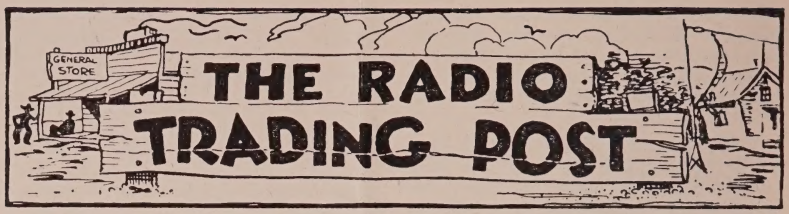
One of the greatest sources of interference to f-m signals originates in automobile ignition systems. It is accordingly desirable to locate the antenna as far from the traffic stream as is practicable.

Where it is desired to receive more than one f-m station, which is the usual case, the dipole antenna should be orientated for a satisfactory signal from all f-m stations. The position where the best signal strength can be obtained will be found by slowly turning the antenna in one direction and then in the other direction, while checking the results on the receiver.

Horizontally Polarized Antennas

Most f-m transmitting stations now use horizontally-polarized antennas. This means that the elements of these antennas are horizontal or parallel to the ground. The receiving dipole should also be installed in a horizontal position. Some f-m stations may, however, employ vertically polarized antennas, and in areas where signals from both types of transmitting antennas are present it may be necessary to make a compromise when installing the receiving dipole antenna. This can be effected by tipping the dipole to a diagonal position, half horizontal and half vertical.

The transmission line between the dipole and the receiver should be as short as possible to keep losses at a minimum. It should also be weather-proofed and should also have the correct surge impedance. When bringing the transmission line into the house it should not be cut, as is sometimes done, and connected to window strips since this will change the surge impedance of the line and will probably cause enough of an impedance mismatch to introduce a loss in signal. The transmission line should always be continuous from antenna to receiver.



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FOR SALE — Limited number of Echophone Commercial Model EC-3 communications receivers with preselection, 2 IF stages, Xtal filter; used, but in excellent condition. Consider trade for radio or photo equipment, or $45 F.O.B. C. I. Ricketts, Box 548, State College, N. M.

SALE OR SWAP — RME 69-550 Kc-32Mc. Receiver, $80. Also Zephyr Model, Ephipone Hawaian Guitar, without amplifier, $60. Both in perfect condition. What have you? Lee's Radio & Electric Service, 217 Tyson Ave., Glenside, Pa.

FOR SALE — Hallicrafters S-40 communications receiver. Good condition. Price, $40. Jim Whitaker, 4020 West 59th St., Los Angeles 43, Calif.

FOR SALE — Hickok tube tester, old model, $15; Capehart record changer, drop type with brush pickup, $35. Louis Girolami, 1821 Tenbroeck Ave., Bronx 61, N. Y.

WANTED — Position. Young man, 26, RCA Institutes graduate; 7 years experience in repair of instruments and radios; first class phone license; Associate Member IRE. Interested in position as lab. technician or station engineer. I. Berman, 7817 Melrose Ave., Hollywood 46, Calif.

WANTED — Sets of drawer-type plug in coils for short-wave receiver. Their ranges are from 14 to 540 meters. I will pay what you think they are worth. Pat. J. Scognamilio, 361-11th St., Brooklyn 15, N. Y.

SELL OR SWAP — For radio equipment, typewriter, etc. Have 35mm Univex Corsair I camera and case in good condition; also have Gonset converter in excellent condition. Best offer. Martin Herbstman, 1806 Sterling Place, Brooklyn, N. Y.

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FOR SALE — 1937 Ford Philco 6 tube auto radio with speaker and tuning head. Price, $50. Southwind gasoline auto heater, fits any car above 1934. Price, $25. Charles W. Archer, Route 6, Caldwell, Ohio.

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FOR SALE — A number of popular books on radio, electricity, physics and math. Like new. Send for list and prices. S. Gershberg, Oak Lane Towers, Apt. 3D, 13 St. and 68 Ave., Philadelphia 26, Pa.

FOR SALE — 9 x 12 cm. Kodak Recomar 33 with Kalart E-1 range finder. Like new. Price, $150, Express prepaid. Jack D. Heslip, 1006 Spring St., Seattle 4, Wash.

FOR SALE — Hickok T53P tube checker, $20.00; Millen No. 90607 23 to 60 megacycles wavemeter, $3. Cardwell MT 100 GD condensers, $3; Astatic D104 mike, $12; RCA 812 and 811 tubes, $2 each. W. Kryger, 912 W. 151 St., East Chicago, Ind.

FOR SALE — Kay Mandolin with new strings, excellent condition. $25. Ghirardi Radio Physics Course, Second Edition, $4. Reply by mail only. Robert J. Helderman, Box 238, Lowell, N. C.

SELL OR SWAP — Cannon "300" miniature motor with flywheel and prop, Flash Brownie (620), two 10" dynamic speakers with xformers. Want signal generator, multimeter, or "Electrovoice" V-1 or V-2 dynamic mikes. Ellis Maris, Jr., R. D. 1, Coatesville, Pa.

FOR SALE — 2 meter transceiver, power supply and tubes, fit in glove compartment. Price, $25. Mark II tank set complete with power supply, etc., $50. Beautifully designed home built Superhet, $35. Want 10 meter mobile rig. Chas. S. Green, Clayton, N. J.

WANTED — National 1-10 UHF receiver, or equivalent receiver or converter covering 10, 6 and 2 meters. C. M. Maer, Jr., 51 Hilhouse Ave., New Haven, Conn.

SELL OR TRADE — Tubes for KW. CW. Xmitter. Also 6 tube 144 mc. transceiver, 115 v. AC., Weston Watt- meter, with eight new 6B4-G tubes. Three 28 V. dynamotors. All inquiries answered. H. L. Ailsligger, 264 W. Broadway, Hoisington, Kan.

WANTED — 1937 Ford auto radio complete with tuning head and controls in A-1 condition. State lowest price in first letter. Cooper Radio Service, Calcium, N. Y.

SWAP — The following items for a signal tracer or a complete N.R.I. Course: Kodak Duex, Ford App. School, Vol 1 and 2 on Electricity, Audels Wiring diagrams and Practical Engineering and Crofts American Electricians' Handbook. James P. Torre, 57 St. Nicholas Ave., Brooklyn 27, N. Y.

SELL OR TRADE — 8 inch circular saw; tubes in sealed cartons, numbers 200-6x6, 100-1Lc6 (1Lc6 same as 1La6). First decent offer. Allan Matros, 2058 Bath Ave., Brooklyn 14, N. Y.

FOR SALE — Crosley 103 auto radio, in working condition, with control head. Needs fuse holder and control head mounting bracket. Price, $10. Also Philco 39-71 portable battery radio, like new. Less batteries, $12. Either item Express Collect. James Wodjick, 65 Main St., (Inkerman) Pittston, Pa.

WANTED — Jackson test oscillator, model 640, and Hickok-Jumbo volt-ohm meter. Will pay cash or will trade Admiral record changer, model R.C. 160, tubes, books and speakers. Austin Radio Service, 1311 Jefferson Ave., Houston 3, Texas.

WANTED — Rider's Manual, Vol. III. Need it desperately. State price, and I will pay it. William Bashta, 113 Bennett St., East Syracuse, N. Y.

FOR SALE — Beam Motors, weigh only 5 pounds, but will take 10 or 20 meter beams very easily. Operate on 18 to 20 Volts AC. $10, postpaid. Steward Ringler, 121 S. 11th St., Reading, Pa.

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WANTED — Rider's Manuals for cash, or will trade. Have 25D8 tube, 70L7's, etc. record changer, and many other items. Will send list on request. Need volumes 5, 6, and 8 to 15. Have many good items to swap. Mr. A. R. Pepe, 3011 Diversey Ave., Chicago 47, Ill.

WANTED — Partner to go in with for some sort of light manufacturing. What do you have in mind? All correspondence kept in strictest confidence. Milton Maultasch, 535 Grand St., Brooklyn 11, N. Y.

WANTED — Used Presto Model K recorder, complete. V. Salmon, 6220 S. Moody Ave., Chicago 38, Ill.

SALE — Radio shop stock; tubes, parts, supplies, etc., at bargain prices. Write for prices and other information. J. C. Thimijan, 715 North 7th St., Lake City, Minn.

FOR SALE — Supreme 504A tube and set tester, in original carton. Price, $60. Television tubes, 7EP4, $18.80, 7GP4, $19.30. G.E. 6 amp. tungar bulbs, $2.95. Murray Fisher, 4929 Old York Rd., Philadelphia 41, Pa.

FOR SALE — Turner crystal microphone with high quality desk stand, cable, and connector, $8.00 (guarantee included). Kelton watch, $10.00. Also old radios and tubes. Peter Bedrosian, 2 Unicorn St., Newburyport, Mass.

FOR SALE — All standard makes of used radios and accessories, power packs, etc. Goldstone Radio, 1279 Sheridan Ave., Bronx 56, N. Y.

FOR SALE — 100 Centralab No. 1464 spring-return DPDT switches at 30 cents each; knob, pendant type, for same at 10 cents each. Jay-Bee Electronic Laboratories, P. O. Box 131, Trenton, N. J.

WANTED — Rider's Manuals 1 to 14 complete, or will buy individual volumes. Ed Everly, Box 461, Waitsburg, Wash.

WANTED — Hewlett Packard audio osc. in good shape. Cash or trade. Michael Schmitz, 2135 Berteau Ave., Chicago 18, Ill.

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FOR SALE — All types of 32 Volt D-C electric equipment. Porter Electric Shop, 487 East Main St., Chillicothe, Ohio.

TRADE — For any good testing equipment. V-2 Electrovoice mike just factory rebuilt; one small steel cutting lathe, very slightly used;one jig saw; eight inch bench rip saw; photo electric unit; Zenith 6V vibrator packs; Mallory 6V pack; 6 V. battery charger. Lovett's Radio and Key Shop, Box 143, Newland, N C.

SALE — 450 corrugated cartons, 8 x 10 x 12½ inches, 200 lb. test. Imprinted one side, $30 for lot, F.O.B., Trenton, N. J. Jay-Bee Electronic Laboratories, Box 131, Trenton, N. J.

SWAP OR SELL — G.E. relays, sensitive D.C., 8000 ohms, 2 S.P.S.T. contacts; also 5000 ohm D.C. relays, with two normally open contacts. Melvin Youngman, 515 South Blvd., Oak Park, Ill.

FOR SALE — Collins 30K transmitter complete, $1,375, slightly used. Mark 2 tank set intact, $35. Shure Crystal mike 70H and stand, $9.50. Ship anywhere, Express charges collect. A. Brizzolari, 146-13 58th Road, Flushing, N. Y.

FOR SALE — Meissner Midget 3-tube battery receiver, tubes and 4 coils, 4" Pm speaker, $14; 8" magnetic speaker at $1.50. All inquiries answered. Madell Reynolds, Route 1, Granville, Tenn.

FOR SALE OR SWAP — Korelle Reflex Camera Ziess F 3.5 and Schineder Telphoto F 5.5; also Bentzen Primarflex, Schineder F 2.8 and case; Leitz binoculars, 8x6; also some makes of German 6x3. Am interested in good communication receiver or what have you in radio line? Edward B. Schofield, 931 Fort Hamilton Parkway, Brooklyn 9, N. Y.

SELL OR SWAP — Good power supply, 110 volts input, output in 3 ranges. Want tube tester or good amplifier. All letters answered. Robert Newbegin, 974 Walnut St., Newton Highlands 61, Mass.

FOR SALE — Supreme model 581 signal generator and frequency modulator. Perfect condition. Price, $60. Challenger Radio, 33-08; 31 Ave., Long Island City. N. Y.

FOR SALE — National Receiver, similar to the NC 100A as listed in 1944 Amateur Handbook. Gus Karalow, 5-174 Shangri La Drive, South Norfolk, Va.

SALE AND WANTED — Xmitting tubes, transformers, chokes, condensers, meters. Write for list. Want BC610 transmitter complete. State model and price. N. K. Stover, P. O. Box 722, York, Pa.

FOR SALE — Complete N.R.I. Course on A.M.-F.M. television, $50. Solar "Quick Check" capacitor analyzer, model QCA-1-60, $20. Also tubes, condensers, controls, resistors, output X, etc. Send for complete list. Chas. Becker, 1350 E. 18 St., Brooklyn 30, N. Y.

WANTED — Modern portable typewriter in good condition. Will pay cash or trade Triplett tube checker No. 2413 in perfect condition. Fred Cobin, 158 East 7th St., New York 9, N. Y.

WANTED — Operating instruction manual on BC 348R receiver. State price. Stanley Vekteris, 2738 E. Venango St., Philadelphia 34, Pa.

SALE OR TRADE — KW phone and CW Xmitter to trade for BC610, or will sell KW for $400. Gold plated C-melody saxaphone and case, $50. B-flat Blessing saxaphone and case, $40. German P-38 automatic, $35. Will trade all the above for BC610E All Band Xmitter. Fred W. Rudolph, Box 516, Stryker, Ohio.

FOR SALE — Radio Designers Handbook by RCA, 75 cents; Advels Electrical Library, Vol. 3, $1; Drake's Cyclopedia of Radio and Electronics, $3; code oscillator with two keys, I.C.A. model 4300, $12. Dan and Ted's Radio Shop, 4355 So. Honore, Chicago 9, Ill.

FOR SALE — Signal generator, Electronic model A-200, frequency, 100 Kc. to 75 Meg., $49.50. Want signal tracer, any reliable make. Ralph Cramer, 402 Beltagh Ave., Bellmore, L. I., N. Y.

FOR SALE — RME-45. Will sell it at $149.50 cash. Robert Greenen, 518 Liberty St., Aurora, Ill.

FOR SALE — 325 watt phone, 500 watt CW transmitter, complete in two 42" cabinet racks; TZ-40's final, TZ-40's modulator, 22 watt speech amplifier, Complete, $375. Abbott TR-4, 2 meter rig, $30. Meissner signal shifter, $50. E. D. Kling, 74 Jefferson Ave., Hastings-on-Hudson 6, N. Y.

WANTED — Audio amplifier transformer unit (including the interstage and output stage) of an RCA Radiola, model 80. Stuart F. Britton, 103-2nd St., Battle Creek, Mich.

FOR SALE — Gernsback, Volumes 1 to 5 service manuals at $4 each; Vol. 1 Auto Manual, $2; Radiocraft, 1941 and 1942, at $7.50 each; many other radio books and magazines dating back to 1909. George Morgan, 125 Mansion St., Coxsackie, N. Y.

FOR SALE — General Electric tube checker, like new, TC3 portable, $40. Guaranteed. G.E. FM tuner converted to new band, $40. Complete, slightly used Presto recorder. Send for details. John C. Converse, 445 E. Grand Blvd., Detroit 7, Mich.

FOR SALE — Vol. 1 of Sam's Photofact folders in binder, $17; Understanding Radio, Watson, $1.50; Radio Engineering, Termen, $3; Radio Amateur's Handbook, Collins, $1; also have other radio books for sale. Send for list. Dan and Ted's Radio Shop, 4355 So. Honore, Chicago 9, Ill.

SELL OR SWAP — RME 45 receiver; Radio City multi-tester 414; 3" oscilloscope (home built); German 3" oscilloscope, uses American 3" C.R.T.; McElroy Deluxe bug; 1000 Kc crystal; various tubes; German receiving and transmitting tubes. E. Kramarski, 5243 S. Paulina St., Chicago 9, Ill.

SELL OR SWAP — McMurdo Silver "Vomax" VTVM and signal tracer, like new, in carton, for best offer. Need tube checker and multimeter. John Owen, 1351 First Avenue, New York, 21, N. Y.

SALE — Excess stock of switches, meters, condensers, radio tubes, P. E. tubes, and radio parts at bargain prices. Write for list. Jay-Bee Electronic Laboratories, Box 131, Trenton, N. J.

SELL OR TRADE — Hallicrafter AC-DC S38 4 band radio, good condition, $45, Express prepaid; Springfield 22 single shot rifle, perfect, $7.50, postpaid. John Moy, Box 169, Canal Station, New York 13, N. Y.

FOR SALE — Radio equipment, parts, tubes, speakers, books. Send list of what you need. Will swap some equipment for a good type of Spanish guitar. All letters answered. Bill Hagara, Box 224, Slickville, Pa.

SALE OR SWAP — Complete N.R.I. Radio Course with Triplett portable model 1175A all-purpose tester, containing signal generator, etc. Signal generator needs repairs. Want photo equipment. J. Crawford, 25 Galloway Ave., Newburgh, N. Y.

WANTED — Riders Volumes 1 through 14. State condition and price. Will pay cash or will swap Triplett signal generator, model 2432, like new. C. Wm. Haberstroh, 1521 Larrabee St., Chicago 10, Ill.

TRADE — 30 watt amplifier, P. M. speaker, crystal or dynamic mike, all like new. Want power tools such as floor edger and 12 volt input and 12 volt output selenium rectifier, or similar at 12 amperes. John Arnold, Box 84, Bluffs, Ill.

FOR SALE — Weston model 695 combination power level, volt, and output meter; calibrated for 500 ohm line; like new. Best offer. Also have other items. Stamp for list. Raymond H. Ives, 822 Windsor Ave, Norfolk 4, Va.

WANTED — Wiring diagram and other data to the H.M.Z.L. 34/K-II Phillips Radio, Holland. Louis F. Kralik, 522 Paine Ave., Toledo 5, Ohio.

WANTED — TCS Navy Transmitter, 12V model; also maintenance manuals for ARC-5, HF and VHF, BC-375E, BC-1016, BC-1206-C, TCS equipment and RBA equipment. T. T. Crittenden, Box 56, Hillcrest Station, San Diego, Calif.

FOR SALE — A.C. model TS-3 Electronic Stethoscope for 105-125V, 50-60 cycles. Slightly used. Service Guide included. Price, $25. Richard Windau, 124 E. Jefferson St., Sandusky, Ohio.

FOR SALE — Thordason 55 watt phone, 80 watt CW transmitter, $125 complete; DC multi-tester, $45; AC-DC multi-tester, perfect condition, $50; also various other meters. G. B. Eichelhardt, 48 Shadylawn Drive, Madison, N. J.

SALE AND WANTED — Majestic, Philco, and many other makes of radios. Forward stamp for bulletin. Want short wave diathermy machines, 0-100 ma meters, Singer drop head sewing machines. Louis A. Goldstone, 1279 Sheridan Ave., Bronx 56, N. Y.

FOR SALE — Christmas cards, 50 for $1, with your name printed on each free. 20 DeLuxe cards, "Mellotone," for $1.95, name printed free on each card. Fred Geyer, 2447 Cortland St., Chicago 47, Ill.

FOR SALE — Hickok 210X 9" Jumbo meter, $48; 203 Electronic, $73; RF 05 3" scope, $95. All are in perfect condition. Write for details, send stamp. E. Sujak, 4209 Elston Ave., Chicago 18, Ill.

FOR SALE — Riders Manual, Vol. III, all pages intact and almost like new. Price, $7.50 Postpaid, anywhere in the country. William Bashta, 113 Bennett St., East Syracuse, N. Y.

SWAP — 8" Dynamic Magnavox speaker with output transformer, in black leatherette covered wooden baffle. Good condition. Want 0-100, or 0-200 microammeter or radio parts. Fred Scarf, 516 McKean St., Philadelphia 48, Pa.

SWAP — Have Hickok 210X, 9" Jumbo meter, infinity ohms per volt. Want Hickok 188X or good signal generator. Edward Sujak, 5321 W. 30th Place, Cicero 50, Ill.

FOR SALE — Complete model 158 RCA oscilloscope. Perfect. Would trade for h. f. signal generator, vacuum tube volt meter, or photographic equipment of all types, either still or 16 mm movie. Want Leica lenses, etc. Beverly Hills Radio Co., 9138 West Olympic Blvd., Beverly Hills, Calif.

WANTED — Position in the repair department of a radio and appliance store. Young man, 27, recent graduate of Temple University, Philadelphia. Experienced in the repair of radios, automatic record changers, and electrical appliances. William B. Blakeman, 1613 N. 7th St., Philadelphia 22, Pa.

FOR SALE — Superior Instrument Co. signal tracer, perfect condition. Price, $10, plus postage for 5 lbs. Arthur Cherry, Jr., Box 65, Sullivan County, North Branch, N. Y.

SALE OR TRADE — QST's, 1937 through 1945, complete in binders and all in good condition. Cash or what have you? F. Harnisch, 386 Henry St., East Hempstead, L. I., N. Y.

FREE — Have radio parts which were dismantled from radio receivers, and will give them to anyone who will pay Express charges upon arrival at their city or town. V. D. Kinard, 1110 W. 4th, Big Spring, Tex.

FOR SALE — Cabinet for RCA Victor floor model radio, excellent condition. First reasonable offer. Daniel Kinley, 4100 La Crosse, Cincinnati, Ohio.

FOR SALE — 9,000 aluminum turbo junction boxes full of useful parts. Sell in lots of 100 or all, 29 cents each; 8,415 feet 10-conductor rubber covered cable, $30 C. B and W Radio and Electronic Co., 3002 East 15th St., Kansas City, Mo.

FOR SALE — 16mm Bell & Howell movie camera, uses 50 foot auto-load magazine. Complete and in excellent condition. Make offer. M. Ruggere, 430 Bennett St., Luzerne, Pa.

SELL OR TRADE — Three Jones electronic timers. Can be used for photo printers and enlargers up to 750 watts, 110-125 V, 50-60 cycles AC. $16 each, or will swap for radio test equipment. E. J. Ledwon, 5428 Melrose St., Chicago 41, Ill.

SELL OR TRADE — No. 351 and No. 1-77-B Triumph AC-DC volt-ohm-mil. meters; 100 watt, 110 volt, American Beauty soldering irons; Diamond 8" lineman's pliers; radio tubes. Want signal generator, V.T.V.M., tube checker, phono-combination. Roby's Swapmart, 1119 Milwaukee Ave., Chicago 22, Ill.

WANTED — Ten fibre wheels of the type that drive the 20 mm Fd variable condenser in the BC-375-E tuning units. Will pay reasonable amount. Franklin Nagy, Mary Ella Hall, Kannapolis, N. C.

SALE OR SWAP — Triplett all purpose tester, V.O.M. signal generator, portable case; musical amplifier; 20 used speakers, all sizes; 25 watt PA system, mike with floor stand, 2 extension speakers, phono top, speaker in PA case. Write for details. Bill Hagara, Box 224, Slickville, Pa.

FOR SALE — Acro Chassis Cradle with set of extra clamps and set of straight clamps. Price, $5. Latest model RME-45 receiver in good condition. Price, $140. General Test Equipment Co. Pen-Oscil-Lite, used very little. Price, $4. Robert Greenen, 518 Liberty St., Aurora, Ill.

FOR SALE — N.R.I. vacuum tube volt-ohm meter complete with tube, batteries, test prongs. Price, $10, Postpaid. Ben Marconi, 120 Gatling Place, Brooklyn 9, N. Y.

FOR SALE — Superior channel analizer, complete with tubes, probes, and instructions. Used very little. Price, $15. Also Readrite tube tester model 432A, with chart. Good condition. Price, $20. Pranger's Radio Service, Box 147, Platte, South Dakota.

WANTED — Any hi-frequency horn to supplement a cone speaker. Prefer W. E. 32A horn with 713A driver, 18" loud speaker. Any transcription turntable, but prefer 12" Presto. Neal Page, 2721 Forest Ave., Berkely 5, Calif.

WANTED — Position as radio operator. Have first class Phone License and Amateur License. Graduate of U.S. Navy Radio Material School. Experience on ship and 23 years of repairing radios. Arthur B. Shaw, 8307 Munson Ave., Niagara Falls, N. Y.

FOR SALE — Equipment for radio shop, including service bench, test panel, tube testers, signal generator, pack for auto radio service. Write for particulars. Sids Radio Service, 49 Christie Ave, Clifton, N. J.

FOR SALE — Test Rite model B-45 signal generator, good condition, complete with cable. Price, $28. Cobb's Radio Service, 9236 Cardoni St., Detroit 11, Mich.

SWAP — Collectors' items, one antique pistol, ball type, folding trigger; one rifle with date 1842. Both items were purchased abroad. Want parts, equipment, or what have you? Thos. A. Koslosky, 2224 E. Canfield, Detroit 7, Mich.

WANTED — Navy veteran wants on-the-job training in electrical or radio repair work, vicinity of Boston preferred. Good knowledge of both electricity and radio. David C. Crimmings, 75 Myrtle St., Medford 55, Mass.

SELL OR TRADE — MarkII transmitter-receiver converted for 6 volt operation, $40; Jackson comparison oscillator and cycle counter, $18; Master Teleplex code oscillator, $25. Will trade for test equipment. E. A. McCall, 3504 E. 26th St., Kansas City 1, Mo.

FOR SALE — Oscillator, 50 kc to 110 mc, 6 bands, $20; McElroy tape recorder, and amplifier, $25; Wollensak 3"-F 3.5 enlarger lens, $25; Mercury II, $70; Argus Speed Printer, $19. All perfect. J. Bourke, 148 Winthrop St., Brooklyn 25, N. Y.

SWAP — Magician's equipment, magic lessons, magic books, magic magazines, books of popular piano music, or large rubber stamp outfit with 10 holders for anything pertaining to radio. Especially want radio courses, equipment, and two radio-telephones. Make offer. J. M. Segel, 5214 Spruce St., Philadelphia 39, Pa.

FOR SALE — Seven pairs of genuine G.E. selsyns, type 5, at $4.75 per pair. Also have Radio City Products electronic multitester, model 661, used very little. Best offer. W3LCI, 4750 Baptist Road, Pittsburg 27, Pa.

SALE — Webster amplifier, $25; two 12" PM speakers in cases, $30; 2-speed record player, $30; Abbott 2 meter trans.-receiver, $50; 115v ac motor, $6; Victor 40B 16mm sound projector, $350; 2 transit tripods, $15; hand cement block machine, $300; movie screens. Grant, 24 Gill Rd., Waverly, Mass.

FOR SALE — Television receiver 7" complete, in beautiful mahogany cabinet. In perfect working order. Price, $295. All letters answered. James Moska, 240 So. 57th St., Philadelphia 39, Pa.

FOR SALE — Model 13A120D28-1, 800 cycle alternator, 1400 watts, 120 volts, 1 phase; G.E. type AS, 500 cycle alternator, 2KW, 110 volts, 1 phase, with exciter. Electric Maintenance Service Co., Inc., 143 Bennett St., Bridgeport, Conn.

FOR SALE — Weston tube checker, model 771, in good working condition. Price, $10. Sent Express, charges Collect. Nicholas E. Basil, 611 1st Ave., Rock Falls, Ill.

FOR SALE — Volometer model 101A. Used very little. Instructions included, $13.50. J. N. Cutler, 239 Utica Ave., Brooklyn 13, N. Y.

FOR SALE — Readrite model 430 tube tester, good condition, $12; Wollensak microscope, 100X, like new, $6; Service model .45 automatic pistol, chrome-plated, perfect condition, $45. F. McCabe, 101 Gordon St., Clifton, N. J.

SELL OR TRADE — Riders Manual Vol. I, $5; Simpson model 240 hammeter, $13; Robeson-Burgess multimeter, $14; Remington S.S. bolt action 22 rifle, $7.50. Need Jackson condenser tester, silver "Vomax," 8" bench saw, A.C. motors up to ½ h.p. R. E. Schmidt, 1029 N. Notre Dame Ave., South Bend 17, Ind.

FOR SALE — VFO built from September, 1946, QST diagram. Sprayed gray to match equipment, 6L6 output. Price, $19. R. Frolich, 7321 Overbrook Drive, St. Louis 21, Mo.

WANTED — Instruction manual covering use of Radiart vibrator tester model P-6. If it is in good condition, will pay fair price. M. L. Hart, 1110 E. Main St., Alhambra, Calif.

FOR SALE — Silvertone portable phonograph, excellent condition, $20; 1936 Chevrolet car radio, one mounting bracket, speaker, $23.50; Traveler portable radio, perfect, with batteries, $28.50; Some 1934-42 issues of Radio-Craft, Popular Science and Popular Mechanics magazines. Write. Frank T. Wyatt, 4610 Speedway, Austin, Tex.

FOR SALE — High fidelity transformers at large discount. U.T.C., Thordarson, Inca-Thermador. Will trade for test equipment in good condition. Radio Communication Service, 4475 Myrtle St., San Diego 5, Calif.

FOR SALE — Approved electronic signal generator, model A-200, and Jackson model 643 V.O.M., $50. Perfect! Roger W. Morse, Box 141, Groveland, Fla.

SELL OR TRADE — German Luger 9mm, excellent condition, holster, 2 clips and about 90 rounds of ammunition; Robot camera, 35 mm, with case; Zeiss Ikon 120 film coupled range finder with case. Want to trade for radio test equipment. Ralph A. Smith, Route 1, Box 430F, Selma, Calif.

SELL OR TRADE — R.C.P. No. 420 S.P. V.O.M.; Triumph No.'s 351 and 1-77-B V.O.M.'s; Chicago Ind. Inst. Co. No. 451 V.O.M.; Drake 200 watt American Beauty soldering irons. Want signal generator, vacuum tube volt meter and tube checker. G. F. Roby, 1119 Milwaukee Ave., Chicago, Ill.

SWAP — Have 5,000 foreign stamp collection, latest N.R.I. Radio Course. Want Rider's Manuals in good condition, and Electronic A-200 signal generator. Give price and details. Larson's Radio Service, Box 123, Red Oak, Iowa.

FOR SALE — Christy Appliance Repair Course, $5. Also various service books and manuals by Rider, very cheap. Write for list and prices. Warren Gilman, Tilton, N. H.

WANTED — Used AC signal generator and army surplus receivers. I have about $40 worth of used model railroad equipment to trade. George H. Hague, 6 Carver St., Fall River, Mass.

FOR SALE — Many makes of radio chassis; also power packs and many other items. Send stamped envelope for return bulletin. Louis A. Goldstone, 1279 Sheridan Ave., Bronx 56, N. Y.

FOR SALE— Triumph oscilloscope, $60; Acorn tubes, types 954, 956, 958 with sockets, $.60 each, postpaid; miniature tubes 9002, 9003 and 6AK5 tubes, $.60 each. Radio Communication Service, 4475 Myrtle Street, San Diego 5, Calif.

SELL OR TRADE — Ferrett 600 Signal Generator, like new. Will sell for $35 or trade for a signal tracer. Salida Music Store, Box 325, Salida, Colo.

SALE OR TRADE — One R.C.P. multimeter model 413, one model 461; one R.C.P. tube & set tester, model 801; one R.C.P. model 803 tube & set tester, built in tube chart; 2 Westinghouse Rectigon battery chargers; signal tracer. All in A-1 condition. Boyd Branch, 1732 1st St., N. W., Washington, D. C.

FOR SALE — Hewlett Packard Model 300A Harmonic Wave Analyser. Wm. D. Crosby, The Superior Electric Co., Bristol, Conn.

FOR SALE — Communication Receiver: RME-69, 550 Kc to 31 Mc, AVC, BFO, 8" PM speaker in matching cabinet. Excellent condition. Best offer. Philip J. Freed, 100 Kingsland Road, Clifton, N. J.

FOR SALE — Precision E-200 Signal Generator in new condition. Complete with instructions. Price, $52.50, Express prepaid. Joseph F. Brown, 34-05 28th Ave., L. I. City 3, N. Y.

FOR SALE — Complete radio repair shop with all test equipment, repair parts, including a good stock of radio tubes, all manuals, and good work bench. John A. King, King's Radio Service, Route 3, Box 77, Kinston, N. C.

FOR SALE — Automatic Record Player. Attractive case, Webster Chicago changer, and 4-tube amplifier. Price, $65. S. Jack Pirkle, 130 S. Jackson St., Oakland City, Indiana.

SELL OR SWAP — Univex Corsair I 35mm camera with built in exposure meter. Best offer, or will swap for radio equipment, parts, etc. Martin Herbstman, 1806 Sterling Place, Brooklyn, New York.

FOR SALE — Army Radio Manuals. Write for numbers available. $2.50 each. Various German Radio Tubes, guaranteed. Write for numbers available. German 2½" O-250 volt ac-dc meters, $2.50 each. Two 110 volt ac, dry disk rectified 8" speakers, $6 each. Albert C. Hart, 4848 Linden Ave., Hammond, Ind.

SALE OR SWAP — One DZ-2 Radio Direction Finder. Complete with loop and dynamotor. Will swap for test equipment. Am especially interested in signal generator, late model, or what have you. John P. Weeks, 762 Patterson, Memphis 11, Tenn.

FOR SALE — Television Receivers, 7", assembled from kits. Like new and guaranteed. Price, $195. Reisman Television Laboratories, 319 Canal St., New York 13, N. Y.

SALE OR SWAP — 1946 NRI Radio Course complete with all kit parts, less soldering iron, prepaid. Best offer, or trade for 12-15 watt amplifying system. Frederick Schamu, 200 3rd St., Liverpool, N. Y.

FOR SALE — Hickok & Triumph 3" Oscillographs, $60 each. Bliley Crystal Controlled Oscillator, $40. Solar CE Capacitor Analyzer, $40. Aerovox 95 LC Checker, $20. All instruments are in good condition. R. Chang, 421 East Lewis, Fort Wayne, Ind.

FOR SALE — 1 BC 191 Transmitter complete with tubes, 1 tuning unit, and instruction manual, but less dynamotor, for $17.50. All letters answered. Brentwood Radio Service Shop, R.F.D., Exeter, N. H.

FOR SALE — BC-348-O. Completely converted with heavy duty power supply and matching speaker, all in perfect condition. Price, $60. Alan W. Umland, Box 25, Waller, Texas.

FOR SALE — Complete set of Riders Manuals at 50% of cost. Contact Francis Typewriter & Radio Co., 141 West 10 St., New York 14, N. Y.

FOR SALE — Vomax V.T.V.M.; meter is damage proof. With instruction booklet, $49. Frank Cotugno, 40 10 108 St., Corona, N. Y.

FOR SALE — Radition Designers Handbook, $.80. Have many other Radio Books., very cheap. Send for list. With each book purchased, I will send one free—most free books are from the Radio Craft Library Series. Also other free books. Send for free list. Dan & Ted's Radio Shop, 4355 So. Honore, Chicago 9, Ill.

FOR SALE — Radio News, Radio Craft, QST, and other radio books of any year. Also Radio & Television Today from 1937 to 1941. All books in fair condition. All letters answered. S. Tommy Wrublewski, 15-17 West 65th St., New York 23, N. Y.

FOR SALE — Collection of Radio Craft Magazines from 1936 to August, 1947, and 23 Radio News. Make offer. Also have two complete sets of plug-in coils, long & short wave, for $5; one Superior Tube Tester and Analyzer, model 1180-S, for $18.50; one Superior Generator model 1130-S, for $18.50; 5 Power Transformer, 6 to 8 tubes, all for $8. A. Lago, 92 Andrew St., Bayonne, N. J.

FOR SALE — Completely equipped radio shop, tools, instruments, technical library, large stock of tubes, etc. For details write to Radio Service Co., 17th St. Extended, R.F.D. 1, Box 13, Virginia Beach, Va.

FOR SALE — Triplett Tube Tester, model 1213. Good condition. Price, $20. Leon J. Kamienski, 1343 N. Rockwell St., Chicago 22, Ill.

FOR SALE — Rider's 1, Gernsback's 2, both, $3.50. Rider's III, IV, V, VI, $7 each; all, $24. VII, VIII, $10 each; both, $16. All in excellent condition and complete. All prepaid, $43. R. J. Clark, Bellmore, N. Y.

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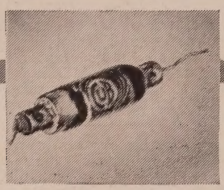
writes Ernest: *"I have saved every copy of 'The Capacitor'... and keep them handy in my shop for reference. Also want to tell you every condenser I have in stock are C-D's. I guarantee... service for 90 days... seldom replace your products. Can't say the same for other brands."*

says C-D: We sure appreciate your sentiments, Ernest. Our good servicemen friends everywhere have been telling us the same thing for years.



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